

**STATUS OF MINERAL RESOURCE INFORMATION FOR THE L'ANSE,
ONTONAGON, AND HANNAHVILLE INDIAN RESERVATIONS OF
NORTHERN MICHIGAN**

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Administrative Report BIA-11

1976

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SUMMARY AND CONCLUSIONS

L'Anse Reservation has the potential for sand and gravel deposits, graphite, uranium, and brick clays. Further geologic work needs to be done to locate them. Ontonagon and Hannahville Reservations have less potential. Hannahville has only sand and gravel that is of current value and this resource is abundant throughout the area. In the distant future, the potential for iron and possibly copper ores may become economically attractive. The isolated Ontonagon Reservation has only limited potential for valuable clay deposits. The copper-bearing Nonesuch Shale which underlies the reservation at a depth of some 4,000 feet, may have future commercial value.

INTRODUCTION

General

This report was prepared for the U. S. Bureau of Indian Affairs by the U. S. Geological Survey and the U. S. Bureau of Mines under an agreement to compile and summarize available information on the geology, mineral and energy resources, and potential for economic development of certain Indian lands. This report concerns the Hannahville, L'Anse, and Ontonagon Reservations in the northern peninsula of Michigan ([Figure 1](#)), and is a compilation and summary of data from published and unpublished sources and personal communication. No field work was done.

No bedrock mineral deposits are known on any of the reservations but, because of cover of glacial drift, which is unconsolidated material deposited

by glaciers, the bedrock beneath the reservations can be examined at only a few localities. The nature of covered bedrock and the potential for the occurrence of mineral deposits can only be surmised indirectly. It is possible however, through an understanding of regional geology to estimate the likelihood of the occurrence of undiscovered mineral deposits and to predict the types of deposits that might be found.

Climate and Transportation

Because the geology and mineral potential of each reservation are distinct, each is discussed separately. However, all share two common obstacles for the development of their resources: climate and distance from markets.

Winter temperatures in northern Michigan average about 16°F but on the coldest days may go below -30° F. This severely hampers quarry operations by causing dangerous conditions for the workmen, frozen water lines, frosted haulage rails, slowed shovel and locomotive operations, and bad stripping conditions caused by freezing and thawing (Morrison, 1942). Hence, quarrying is usually done in the milder months, excess material is stockpiled, and any necessary processing is done in the colder months. This increases the cost of the quarry operation by requiring large storage facilities. In some instances, quarrying is recessed during the winter season.

The L'Anse and Hannahville Reservations are adequately serviced by good roads and nearby rail transportation; but because of their distance from any major market the cost of either road or rail transportation is an important economic consider-

ation and may be prohibitively high for the quarries to compete with sources in other areas.

Severe winter temperatures negatively influence the one factor, cheap lake transportation, that might alleviate the problem of distance from markets. Because Lake Superior is frozen and therefore closed to transportation from December to April, few small shipping firms exist. Many towns, such as L'Anse, which are situated on fine bays, have no deep draft or public docks because lake shipping is done by large companies who maintain their own docks. In the future, docking facilities may improve and small shipping companies may increase in number as the result of the ingenuity being used to extend the shipping season. Several of the larger harbors are now keeping the water circulating by using air bubbles. Also, ice booms, which are essentially chains of logs, were found to be effective in keeping the St. Lawrence Seaway open; they are now being tried in other places. Most recently, air cushion vehicles which caused standing waves that shatter even hard unbroken ice are being used to augment the efficiency of the ice breakers.

L'ANSE RESERVATION

Introduction

Keweenaw Bay divides the L'Anse Reservation into two noncontiguous sections. The western section includes the town of Baraga, population 991, and the village of Assinins. U. S. Highway connects these towns and ties the western part of the reservation with the eastern (Figure 2). The eastern section is larger but more remote, the only

access being by rural roads or unimproved dirt tracks from U. S. 41, which follows the reservation's western border. Rail transportation is provided by the Soo Line.

L'Anse (population 2,397) is the largest community within 60 miles of the reservation. Although it is located at the head of Keweenaw Bay, deep draft dock facilities do not exist, and the town's major industry, a Celotex plant, ships by rail.

The land surface rises gradually from the lake and is well drained with no major lakes or swampy areas. Streams, the largest being the Silver River, flow generally northward across the reservation and into Lake Superior. Mt. Curwood, the highest point in Michigan (elev. 1980 feet), is about 2 miles east of the reservation.

The reservation totals about 13,800 acres of which about 5680 acres are held by the tribe and about 8125 acres are allotted land held by individual Indians. The allotted lands, generally 40- or 80-acre plots, are randomly scattered throughout the reservation. Of the total acreage, the tribe does not own the mineral rights on at least 2800 acres (Figure 3). This was land repurchased from private owners in the 1930's by the U. S. Government under the Farm Security Act. Some of the previous owners reserved the mineral rights.

Geology

The geology of northern Baraga County is only superficially known, and almost no detailed work has been done in or near the reservation. Much of the reservation is not easily accessible, the bedrock is complicated, much of the bedrock is covered by

glacial deposits and dense vegetation and there are no known economic mineral deposits. The area is underlain by Precambrian rocks and has had a complex geologic history. The rocks in the south-east part of the reservation (Figure 4) formed more than 2.5 billion years ago (Precambrian W). They are mostly granitic gneiss (Wgn) but contain numerous bodies of dark colored hornblende gneiss (Wh). The hornblende gneiss is probably older than the granitic rocks and may have been derived from volcanic rocks. These pre-2.5 billion year rocks are overlain by metasedimentary rocks about 2 billion years old (Precambrian X) that form a northeast-trending belt crossing the reservation. These are mostly rocks of the Michigamme Formation (Xm) and are black slate with some graywacke beds. A unit of feldspar-rich quartzite (Xmg) and a thin iron-formation member (Xm) also occur locally near the base of the Michigamme. Slate and graywacke of the Michigamme are commonly rich in pyrite. The original horizontal layering is now complexly folded.

About 1.1 billion years ago (Precambrian Y) dikes and plugs of diabase were intruded into the metasedimentary and granitic rocks.

The northwest part of the reservation is underlain by Jacobsville Sandstone which was deposited over the metasedimentary rocks. The Jacobsville is, at most, about one billion years old and may be considerably younger. It is brownish, reddish, or white feldspar-rich sandstone, commonly cross-bedded. It has not been significantly altered or deformed and the original sedimentary layering is still horizontal.

The cross-section (Figure 4) indicates that most rock units dip to the north. A vertical drill hole

through the Jacobsville Sandstone, for example, would go through down dip extensions of the Michigamme Formation, and enter granitic gneiss.

Mineral Resources

General

No metallic mineral resources are known within the reservation but there is some potential for undiscovered deposits. Graphite, slate, iron ore, and sandstone have been mined or quarried near the reservation. More recently, uranium prospecting has been done both on and in the vicinity of the reservation. Naturally sorted sands, gravels, and clays are also found through much of the reservation.

Metallic Mineral Resources

Uranium. Concentrations of uranium have been known for more than 20 years in black slate near the Taylor mine just south of the reservation (see Figure 4) and along the Huron River about 11 miles east of the reservation (Vickers, 1955). Both are small non-economic bodies but their presence has spurred exploration for larger deposits, and several companies are currently exploring these rocks. Their results are not known, but judging from the amount of work being done, it seems likely that some favorable signs have been found. Because of this there is a fair potential for uranium in the black slate of the Michigamme Formation (Xm) on the reservation.

During the 1940's, there were several efforts to find a commercial uranium deposit. The Ford

Motor Co. and Kerr-McGee both had prospects in eastern Marquette County near Palmer, and the U. S. Geological Survey sampled the graphitic slates from the old Detroit Graphite Co. quarry. Also, a survey was conducted within the reservation boundaries in the Pike's Peak area west of Huron Bay (Spiroff, 1958).

The report on the Detroit Graphite Co. quarry describes the uranium as being concentrated in a highly weathered dike which, because of glacial drift and vegetation, is exposed only where it passes through the quarry (Vickers, 1955). Relatively unweathered dikes, probably of more recent age, also occur near the quarry, but contain no concentration of uranium. The elemental uranium content of rock samples taken from the weathered dike at the quarry face is as follows:

Black slate	.003 - .004 percent
Weathered dike	.005 - .037 percent
Selected sample	.068 percent

The "selected sample" was taken from the quarry floor where the dike was exposed by the short-lived reactivation of the slate quarry in 1950-51. Vickers' study included only chip sampling, and there was no trenching or drilling. He concluded that this dike probably contains uranium concentrations greater than 0.1 percent outside of the area sampled and that other uranium-bearing dikes may occur in the area.

There are anomalous radioactive areas in the Pike's Peak region. Although much of the Pike's Peak area is within the reservation boundaries, it is no longer Indian owned. In 1958 a uranium prospect at Pike's Peak was investigated by diamond

drilling and trenching (Stam, 1958). The anomalous geiger counter readings seem to be associated with bodies of lean, cherty iron facies of quartzite in contact with gneiss. Two such anomalies were located. The highest Geiger counter readings were found at the southern contact of the more easterly anomaly, but drilling and trenching failed to locate significant uranium concentrations. The other quartzite-gneiss contacts were not tested but Stam recommended additional electromagnetometer and scintillometer surveying.

Diabase dikes occur throughout the area as shown on the U. S. Geological Survey Geophysical Investigation Map GP-608 (Meshref and Hinze, 1970). Where these dikes cut the Michigamme Slate, they may create a condition similar to that of the Detroit Slate Co. quarry. However, this area has not been thoroughly searched because of its isolation and the thickness of glacial cover and vegetation.

Iron. An iron deposit occurs south of the L'Anse Reservation between the northern and southern graphite belts in sec. 9, T 49 N., R. 33 W. This deposit, in the upper part of the Michigamme Formation, is in a shallow syncline dipping gently to the west. It is "soft ore" which is derived from oxidized iron-formation. Such ores have a diversified mineral composition, are porous and very friable. The most common ore minerals are hematite and martite; specularite and goethite are all of secondary importance (Tyler, 1949, p. 1112).

Between 1880 and 1883 the deposit was worked as the Taylor Iron Mine by Pickands, Mather, and Co. A total of 31,784 tons of soft iron ore with a mineral composition of 35 percent

goethite, 25 percent hematite, and 40 percent quartz (Heising, 1966), was produced from an open pit and several underground workings. Later, the Ford Motor Co. acquired the property and in 1925 explored it with 24 diamond drill holes. No commercial ore was found. In 1952-53, the property was again studied. The ore was analyzed and beneficiation processes were laboratory tested (Heising, 1966). Chemical analyses showed the

following percentage composition: Fe - 27.3, SiO₂ - 45.8, P - 0.45, Mn - 0.91, and ignition loss - 5.9. The analyst notes that "this sample is a few percent lower in iron content than the usual nonmagnetic taconite and attention is directed to its high phosphorous content." The sample was also given a reductive roast in a hydrogen atmosphere with the following weighted results:

	Weight (percent)	Fe	Analysis, percent SiO ₂	P	Distribution, percent Fe
Magnetic	45.8	56.2	13.8	0.40	87.5
Nonmagnetic	54.2	6.8	----	0.52	12.5
Composite	100.0	29.4	----	----	100.0

Core samples from the drilling indicate that 70,000,000 tons of material of this quality lie within the drilled area. The ore probably extends both northward and southward from the drilled area (Spiroff, 1962).

The literature mentions no other occurrences of iron-formation with concentrations of iron great enough to be considered a workable deposit. Iron-formation is exposed a few miles east of the reservation and it is likely that it also occurs in the subsurface beneath parts of the reservation as shown schematically in Figure 4. Parts of the iron-formation may be of commercial quality but as it is thin and at probably great depth beneath the surface, it cannot be considered an important mineral resource today.

Copper. There is some potential for copper mineralization in the slate and graywacke (Xm). Recently a hole about 1100 feet deep was diamond-drilled one mile east of the reservation (Figure 4) to test a geochemical anomaly found in soils. The drill core consists of black slate with a few interbeds of graywacke. Almost the entire length is rich in pyrite which comprises as much as 20 percent of the rock in some beds. Pyrite is a mineral that is commonly associated with ore deposits, but is also common in otherwise barren rock. A few traces of chalcopyrite, a copper bearing mineral, were also found but none of the rock approached commercial grade for copper ore.

Nonmetallic Mineral Resources

Graphite. Graphite is found a few miles south of the Reservation, where it occurs in the slate of the Michigamme Formation in two bands known as the "southern" and "northern" graphite belts.

Graphitic slates from the southern belt have a long history of production, having first been worked in 1888 by the Detroit Graphite Co. Quarrying was sporadic and had ceased by 1928. Production averaged about 500 tons a year and was used entirely in paint manufacture. A second company, the Hathaway Graphite Co., produced from the same "southern belt," shipping from 1901 to 1908 when it went into receivership. The Northern Graphite Co. later operated from this same site. The graphite produced from this quarry was used for carbons, light bulbs, and paint manufacture (Michigan Commissioner of Mineral Statistics, 1888-1908 vols.). The quarries remained inactive from 1928 until 1950 when a Canadian Company, Ventures, Ltd., again opened the abandoned Detroit Graphite Co. quarry. The product was to be used for base metal reduction. According to the

Daily (Houghton) Mining Gazette, Ventures, Ltd., did a considerable amount of searching for the right type of "graphite affiliate" but the quarry was closed within 2 years after reopening.

The graphite quarries are 2 miles south of the reservation in sec. 9, T. 49 N., R. 33 W. They are on the high plateau of the Huron Mountains in an exposure of slates along the north side of the deeply incised Plumbago Creek. The slates have a total thickness of about 150 feet, of which the top 60 feet is highly graphitic. They are underlain by quartzite and overlain by a thick iron-formation (Zinn, 1942, p. 4). The entire area is covered by a glacial drift varying from a few feet to as much as 25 feet in thickness.

In 1942 the Michigan State Geological Survey (Seaman, 1942) undertook a study to determine the market value of the deposits in the southern belt. A series of samples covering a length of 53 feet along the strike of the graphitic slate was taken from the old Detroit Graphite Co. quarry. Chemical and microscopic analyses were performed on these samples. The results of chemical analyses are as follows:

Sample Number	Total carbon (percent)	Silica (percent)	Iron (percent)
1	30.09	51.24	2.8
2	31.16	44.04	3.6
3	32.05	-----	---
4	31.72	-----	---
7	31.97	43.38	4.2
8	31.91	39.72	4.8
9	29.11	44.02	4.9
10	28.40	48.24	5.6
11	29.42	44.68	4.6
13	29.59	41.30	5.6
14	31.32	36.90	5.1

The examination, which included microscopic and flotation tests, indicated that the ore had disadvantages which in 1940 were economically insurmountable. The microscopic examination of a single sample indicated that the size of the graphite grains was less than a 400 mesh. Because of the fine grain the testing laboratory failed to achieve a concentration of more than 40 percent total carbon by flotation methods. The examination also disclosed that of that 40 percent only about 75 percent was "graphitic" carbon. It was concluded that the product from this quarry could not yield graphite of commercial quality.

Prospects for the future development of graphite from this area have changed somewhat. The U. S. Bureau of Mines Minerals Yearbook for 1972 and 1973 (Willard) report that the world market price for high grade flake graphite continued to rise. Political unrest in some of the major producing nations has caused a shortage of supply. Such shortages have led to attempts to substitute the more abundant amorphous graphite for the more select "flake." In 1973, amorphous graphite imports increased 21 percent. Since most United States graphite deposits that have been worked successfully are amorphous, there is now a revival of interest in finding new deposits and in reopening old mines (Willard, 1973, p. 584), a situation that brightens the picture for amorphous graphite deposits such as those in northern Michigan.

The technology for handling fine grained amorphous graphite, such as the northern Michigan deposits, has also been improving. An article, published in the Journal of Mines, Metals, and

Fuels (Sahu and Mungee, 1972) describes a successful beneficiation process for graphites from Indian with similar chemical and physical characteristics. The Indian graphite tested had the following composition: graphitic carbon, 24.4 percent; silica, 46.5 percent; iron oxide, 4.12 percent. This sample had a mesh size of 200 and was concentrated to 48 percent graphitic carbon after one treatment. These authors state that "repetition of the (beneficiation) process in a series of identical cells is envisioned to further improve the quality of the product."

Graphitic slates of the northern belt occur about a mile north in sections 4 and 5 of the same township and range. No known production has come from the northern deposits. Evidently, the deposits have not been extensively tested.

Both the southern end northern belts of graphitic slate lie outside the reservation but the slate is believed to be a wide band that extends diagonally across the reservation through to the area of the Arvon Slate quarry (Bodwell, 1972, map). In addition, exposures of slates are known to occur along the valley of the Silver River (Baraga County Road Commission Map, 1935) and Bodwell maps slates southwest of the head of Huron Bay. It is not known if these slates are graphitic.

Slate. The Michigamme Formation is characterized by its black shale and slate beds. In numerous places the beds have such purity, uniformity of color, and fine grain that they have been quarried for building slates. Most of the quarries were operated before 1900. Arvon, 2 miles east of the reservation, was the center of quarrying activities

at that time. From 1872-92, two major quarries were operated in Arvon by several companies succeeding each other. The operating companies may have failed to prosper for such reasons as the small size of the quarry blocks making them difficult to handle, lack of cheap transportation, and possibly, poor quarrying methods (Allen, 1918). Slates suitable for curb-stones were quarried from the stream bed in L'Anse. The Baraga County Road Commission Map shows two abandoned quarries several miles to the southwest of L'Anse (Figure 2).

Although no reference could be found describing actual quarrying on the L'Anse Reservation, slates are known to exist there. The Baraga County Road Commission Map notes that they crop out along the Silver River, and the slate band is thought to extend across the reservation from the Detroit Graphite Co. quarry to the Arvon area.

Kiril Spiroff (1962) reported on some testing of the bloating properties of the graphitic slates from the Taylor mine area. Shales and clays that bloat at a low temperature are valuable for use as lightweight concrete aggregate. The slates failed to expand sufficiently and therefore are unsatisfactory for concrete aggregate.

These slates will probably not offer any chance for economic development in the future. The use of slate as a building material is much reduced today. The market is satisfied by substitute materials or other sources of slate which are closer to markets and already accepted by the building trades. There is chance for some small development to satisfy occasional demands for slate as riprap or road metal.

Sandstone. The massive Precambrian Y Jacobsville Sandstone is the bedrock for most of the northern part of the L'Anse Reservation and is exposed in many places along the Keweenaw Bay beach. The sandstone is conspicuous in its exposures because of its cross-bedding and bright red color. Certain parts of the formation have distinctive white streaking, (Hamblin, 1958). The sandstone is fine-grained, quite soft and is easily quarried, shaped, and carved. Upon exposure it becomes much harder and resistant to weathering (Kirkby, 1964).

In the era of the popularity of "brownstone" houses, this massive red sandstone was a popular building stone both locally and in markets as far distant as Detroit, New York City, New Orleans, Denver, and even Liverpool, England.

In 1887, the first quarries were opened at Marquette and L'Anse and 70,000 cubic feet of building stone was shipped. By 1889 production from the quarry at L'Anse ended because of competition from a larger operation at the town of Jacobsville about 15 miles distant. Shipments from Marquette and Jacobsville totaled 750,000 cubic feet in 1889. By 1911, production of Michigan sandstone (an economic term) had almost ceased (Kirkby, 1964).

A revival of sandstone quarrying in northern Michigan is unlikely for several reasons: steel now provide the strength needed to support large buildings; quarrying is a labor intensive industry and rising labor costs add greatly to the cost of the product; red sandstones are not currently in favor with architects; and the cost of transportation to

markets is, as always in northern Michigan, the decisive limiting factor (Johnson, 1973).

Clay. Clay has never been an important product of Baraga County, but in the late 1800's a soft mud brick was manufactured just north of L'Anse in answer to local demand. By 1926 no trace remained of the plant (Brown, 1926). A sample (No. 105) of the clay that was being used by this brick plant was tested for the Brown report, with the following results:

Sample No. 105
SW¼ sec. 35, T. 51 N., R. 33 W.
Plasticity .314 gm. water per gm. clay.
Average linear drying shrinkage 8.4 percent.
Average tensile strength about 125 lbs. per sq. in.
Red clay. Molded easily.

Cone No.	Cone Temp. °C.	Porosity	Linear Shrinkage (percent)	Bulk Specific Gravity	Hardness	Color
010	950	.360	0.2	1.61	Soft burned	Salmon pink
08	990	.378	0.2	1.60	Soft burned	Salmon pink
06	1,030	.376	0.4	1.61	Soft burned	Salmon pink
04	1,070	.357	0.9	1.64	Soft burned	Salmon pink
02	1,110	.085	10.2	2.20	Hard burned	Brown
1	1,150	.018	12.0	2.33	Vitrified	Chocolate
3	1,190	---	----	----	Melted	-----

This indicated that the clay was not suitable for a hard-fired brick but would make a building brick, clay tile, or vitrified brick, although the vitrified brick would be brittle and easily broken. This clay was from the bed of Glacial Lake Nipissing.

Another sample (No. 106), taken from the bed of Glacial Lake Algonquin about 6 miles west of the western boundary of the reservation, was easy to mold and fired well. Brown suggested that this deposit be further investigated as a source of large reserves for material usable for making all forms of building brick and tile. The test results are as follows:

Sample No. 106
SW $\frac{1}{4}$ sec. 31, T. 51 N., R. 34 W.
Plasticity .306
gm. water per gm. clay.
Average linear drying shrinkage 6.6 percent.
Average tensile strength about 93 lbs. per sq. in.
Contains pebbles -- not lime.
Red clay. Easy to mold.

Cone No.	Cone Temp. °C.	Porosity	Linear Shrinkage (percent)	Bulk Specific Gravity	Hardness	Color
010	950	.360	0.2	1.60	Soft burned	Light red
08	990	.357	0.2	1.60	Soft burned	Light red
06	1,030	.320	1.3	1.67	Soft burned	Light red
04	1,070	.199	5.5	1.99	Hard burned	Red
02	1,110	.043	11.2	2.31	Vitrified	Red
1	1,150	.017	11.7	2.31	Vitrified	Choco. red
3	1,190	.023	8.0	2.10	Vitrified	Choco. red
5	1,230	.022	5.4	1.97	Vitrified	Choco. red
7	1,270	---	---	---	Viscous	-----

The recent testing of clays (Miska, 1969) from northern Michigan to determine their suitability as iron ore pellet binders included no samples from Baraga County. There were samples representative of the clays from the beds of Glacial Lakes Algonquin and Duluth taken from Houghton and Ontonagon Counties. These are the same ancient glacial lake deposits that occur over the greater part of the L'Anse Reservation and might be expected to present similar physical and chemical properties. These glacial clay samples were found unsuitable for pellet binder. No sampling of clays from Lake Nipissing was done and there remains some chance that these clays might prove to be more suitable. These clays are limited in extent since the Lake Nipissing shoreline was only 15 feet above the shoreline today and clays from Lake Nipissing could be found only within this interval.

None of the other valuable clays such as bentonite, ball clays, or fuller's earth, which can be economically transported great distances, have been reported from this area.

Sand and Gravel. Because of the area's glacial history, naturally sorted sands and gravels are available throughout the reservation. In 1973 there were 47 State Highway Commission sand and gravel pits in Baraga County (Michigan State Highway Comm., 1973, 7-1). Many of them lie within several miles of the reservation; seven actually lie within the reservation boundary but only one appears to be on Indian-owned land. Statistics from the Bureau of Indian Affairs for sand and gravel production from the L'Anse Reservation for the past 10 years show only 3,000 cubic yards produced from the reservation and this was

all in 1967. Because of the general availability of sand and gravel in this region and the prohibitive expense of transporting them even short distances, any production would necessarily yield only an intermittent income.

Recommendations

No work related to metallic mineral resources is recommended in the L'Anse Reservation at this time.

Since bricks are not currently being produced in Northern Michigan, some effort should be made to study the feasibility of operating a small brick or tile plant and efforts should be made to locate a suitable clay deposit.

If the market price of graphite continues to rise, detailed geologic and geophysical exploration should be conducted in hopes of locating a graphite deposit on Indian lands. If one is found, chemical and beneficiation tests should be undertaken to determine if the product could be made acceptable for the market. During any such field investigation, the possible occurrence of a uranium deposit should be kept in mind and the exploration expanded to include coverage for radioactive minerals.

Sand and gravel is the single currently marketable resource. Specific occurrences should be located and tested so that the Indians can compete in the market for this material. Only an intermittent income could be expected from any sand and gravel Production because of its general availability in this region and because of the prohibitive expense of transporting this material even short distances.

ONTONAGON RESERVATION

Geology

Introduction

The Ontonagon Reservation is in northern Ontonagon County on the west shore of the Keweenaw Peninsula (Figure 1). Only 320 acres remain in Indian ownership. It is held in four 80-acre plots; two tribal and two allotted (Figure 5).

There is no direct highway access to the reservation. A light duty road connects the town of Ontonagon to an unimproved dirt road which leads to the 80-acre tribal holding in the northwest corner of section 26. There are no roads to the other plots and all of them are inland from the coast of Lake Superior. The nearest railroad is the Chicago, Milwaukee, St. Paul, and Pacific at the town of Ontonagon, approximately 15 miles away. Ontonagon itself is a small town with a population of 2,358.

The land surface rises gradually southward from the lake and attains an elevation of about 50 feet above lake level at the south boundary of the reservation. The West Sleeping River flows northward through the reservation. A few exposures of bedrock occur along the Superior shoreline but the bedrock in most of the reservation has a mantle of unconsolidated deposits. These deposits are mostly sediments deposited in an ancient lake that stood at a higher level than the present Lake Superior during the final glacial retreat about 10,000 years ago.

There are a few exposures of bedrock within the reservation and several more within a mile or two of it, mostly along the coastline of Lake Superior. The bedrock of the area has recently been mapped (Whitlow, 1974) and this report is based principally on Whitlow's work. Aeromagnetic data were compiled by Zietz and Kirby (1971) and gravity data were compiled by Bacon (1974).

The entire reservation is underlain by the Precambrian Y Freda Sandstone, one of the youngest units in the Precambrian of Michigan. The Freda was described by Whitlow (1974) as mostly red, brown, and gray colored, fine-grained quartz sandstone, with lesser amounts of shale. These rocks were deposited in a very great thickness about 1100 million years ago. The amount presently preserved is in excess of 4000 feet thick within the reservation. The originally horizontal rock has been gently tilted but inclinations are generally less than 5° from horizontal.

The Ontonagon Reservation was covered several times by ancient glacial lakes that were ancestral stages of present-day Lake Superior. Two of these lake bottoms cover most of the land surface (Leverett, 1928, plates 7 and 8). Sediments from Lake Nipissing, the most recent glacial lake, are just a narrow band paralleling today's shoreline and are found from the waters' edge to about 615-foot contour. These sediments overlie the sediments of the earlier Glacial Lake Algonquin, which had a shoreline that stood at 1,020 feet and therefore covered the reservation's entire land area. Today's surface deposits are the unconsolidated sediments that were deposited on the lake bottoms.

The unconsolidated material consisting of clays, sands, and gravels has been naturally washed and sorted by the water and wave action of the lake.

Although the geologic data are scant, the relationships are simple enough and known well enough on a regional scale to infer the nature of the bedrock in areas of the reservation without exposures.

Mineral Resources

General

No economic metallic mineral resources are known in the reservation. However, one or more valuable clays might be found in the glacial lake deposits.

Metallic Mineral Resources

The Nonesuch Shale which underlies the Freda Sandstone contains copper ore that is presently being mined at the White Pine mine about 25 miles southwest of the reservation. Basaltic rocks underlying the Nonesuch were previously mined for native copper about 15 miles south of the reservation. Both units probably are beneath the reservation at depths of 4000 feet or more and although they may be mineralized, they are at a depth where exploration and mining are difficult and prohibi-

tively expensive. The great depth of the Nonesuch Shale in this vicinity is indicated by a Texas Petroleum Corp. exploratory diamond drill hole just south of the reservation in sec. 11, T. 52 N., R. 38 W. When drilling was halted at 3,075 feet, the hole was still in the Freda Sandstone and had not reached the top of the underlying Nonesuch Shale (Figure 5). There is little likelihood of discovering ore in these units, within the reservation in the foreseeable future.

Nonmetallic Mineral Resources

Clay. Since the Ontonagon Reservation is so distant from any market, only the more valuable clays, such as kaolin or clay for use as iron ore pellet binder, could be considered of economic importance in this isolated area.

Several studies done concerning special properties of clays from Michigan (Brown, 1926; Miska, 1969) have not included samples from this immediate area. In fact, no testing of clays from sediments representing Lake Algonquin or Lake Nipissing on this western shore of Lake Superior has been reported since a single sample of slip clay was analyzed in 1926 (Brown, 1926). Unfortunately, this sample underlies the clay on the surface and may represent clay from the earlier glaciation, Lake Duluth. The following results of this test show the sample to be a high quality slip clay.

Center of sec. 17, T. 50 N., R. 33 W.
Plasticity .288 gm. water per gm. clay.
Average linear drying shrinkage 1.6 percent.
Average tensile strength about 20 lbs. per sq. in.
Pink slip clay. Very soft and like flour.
Almost no plasticity. Hard to mold.
Would not come through extrusion press.

Cone No.	Cone Temp. °C.	Porosity	Linear Shrinkage (percent)	Bulk Specific Gravity	Hardness	Color
010	950	.447	0.4	1.44	Soft burned	Flesh pink
08	990	.459	0.2	1.45	Soft burned	Flesh pink
06	1,030	.458	0.2	1.44	Soft burned	Flesh
04	1,070	.442	0.5	1.45	Soft burned	Flesh
02	1,110	.267	7.8	1.82	Hard burned	Lite brown
1	1,150	.015	16.0	2.30	Vitrified	Brown
3	1,190	----	----	----	Viscous	Brown

Conclusive evidence that valuable clays occur on the Ontonagon Reservation does not exist. The paucity of information about the chemical and physical characteristics of the clays from Lake Algonquin and Lake Nipissing in this part of Michigan is probably because of their accessibility. Still, clays are abundant as shown in the water well drillers' logs quoted in the Michigan Geological Survey Water Investigation for Ontonagon County (Doonan and Henrickson, 1969).

Recommendations

Because of the small extent of the Indian holdings, their limited accessibility, and the minimal chance for the discovery of any mineral deposit that can be worked profitably for the current market, no further work should be done in the area at this time.

HANNAHVILLE RESERVATION

Introduction

The Hannahville Reservation is a fragmented reservation containing about 3,400 acres of land in northern Menominee County ([Figure 1](#) and [Figure 6](#)). The tribal lands are reached by medium or light duty roads nowhere more than 7 miles distant from U. S. Highway 2 which divides the reservation ([Figure 6](#)). This highway gives access to the Lake Michigan port city of Escanaba, (population 15,600), about 15 miles distant. Two railroads service the area: The Soo Line passes through the northern section of the reservation, and the Chicago and Northwestern parallels U. S. 2.

The bedrock in this area is almost completely covered by glacial drift. Northern Menominee County is recognized as one of the classical exam-

ples of drumlin topography (Hussey, 1936). Some of the Indian-held lands south of U. S. 2 are covered by a ground moraine but the greater part of the reservation is covered by drumlins. These drumlins are composed of unsorted sands, gravels, and clays. They range from $\frac{1}{2}$ to $1\frac{1}{2}$ miles long, from 10 to 100 feet high (Leverett, 1911), and cover nearly 50 percent of the land surface. The intervening land tends to be marshy. Eskers, long narrow ridges of sorted sands and gravels, are more randomly oriented and occur throughout the drumlin area. The area drains to the south through Forty-seven Mile Creek and its tributaries, eventually reaching Lake Michigan.

Geology

The reservation is on the northwest edge of the Michigan basin, a saucer-shaped structural depression. Erosion has left each successively lower bed exposed around the edge of the next higher formation. The beds near the Hannahville Reservation are the older Ordovician rocks near the edge of this great saucer. Here the formations are nearly horizontal or gently dipping to the southeast with only an occasional sag or swell (Morrison, 1942).

The Hannahville Reservation is underlain by nearly flat-lying dolomite of the Prairie du Chien Group of Ordovician age. It is generally gray to buff crystalline dolomite, and commonly contains quartzose sandy beds. In the subsurface it is underlain by medium to coarse grained brownish and yellowish sandstone of the Munising Formation of Cambrian age. All available information on these rocks is from water well drilling records. The most complete description is from a deep well in T. 38

N., R. 26 W. ([Figure 7](#)) a few miles west of the reservation. At the well site, 240 feet of dolomite overlie 140 feet of Munising Sandstone which in turn overlies Precambrian rocks. The boundary between the Precambrian and Cambrian represents a great hiatus in the geologic record of the area, a span of over 1.5 billion years separating the time of formation of the two rock units. The sedimentary layering in the Cambrian and Ordovician rocks is inclined very gently, toward the east. Therefore, on the reservation the dolomite (Prairie du Chien) and the sandstone (Munising) extend to a somewhat greater depth beneath the surface than in the area of the deep well.

The buried Precambrian rocks are the most interesting from the standpoint of mineral resource potential. Data on them are fragmentary but some reliable inferences concerning their nature can be made. About 15 miles west of the reservation the Precambrian rocks crop out. They have been studied in detail by Bayley and others (1966). The area includes the currently inactive Menominee Iron Range, which in the past has yielded large amounts of iron ore. The iron-bearing unit, the Precambrian Vulcan Iron-formation, is strongly magnetic, and can be traced eastward on aeromagnetic maps (Zietz and Kirby, 1971) beneath the Cambrian and Ordovician rocks. The northernmost anomaly on [Figure 7](#) is the direct extension of that anomaly and defines the approximate location of the Vulcan Iron-formation in the subsurface near the reservation. A drill hole on this anomaly in Escanaba, about 10 miles east of the reservation, has confirmed the presence of the iron-formation (Allen, 1918). To the north of this anomaly we infer the Precambrian rocks to be a complex

terrane of metasedimentary rocks, possibly including some iron-formation, and older granitic rocks.

Several other anomalies in the south half of Figure 7 may also be associated with the Vulcan Iron-formation and suggest that structural complications have repeated the outcrop belt of the Vulcan here, as they have in the exposed part of the range to the west. The drill hole in T. 38 N., R. 26 W., intersected Randville Dolomite at depth. The Randville is a Precambrian unit stratigraphically beneath the Vulcan and would be expected to be found just north of the Vulcan outcrop belt. Its presence this far south strongly indicates structural repetition of units and it seems likely that these southern anomalies are also caused by the Vulcan Iron-formation.

In short then, we infer with reasonable assurance that most of the Precambrian beneath the reservation is complexly deformed metasedimentary rocks similar to those in the Menominee Range to the west. They probably include such rock types as quartzite, slate, dolomite, and iron-formation, but the distribution of these rock types cannot be determined. In the northernmost part of the reservation, there may be some older granitic rocks.

Mineral Resources

Metallic Mineral Resources

Iron. The most obvious and likely iron resource is in the Vulcan Iron-formation. On the Menominee Range many bodies of high grade ore that were secondary concentrations within the Vulcan were mined. At present there is a limited

market for such "natural ores". Processed and pelletized material from lower grade iron-formation, being a more desirable blast furnace feed, has largely supplanted ores of the type known on the Menominee Range in the U. S. market.

It is very likely that some natural ores occur in the Vulcan where it is buried beneath younger rocks. However, because of the present market, the great resource of more desirable ores elsewhere in the Lake Superior region, and the problems of discovering and mining a deeply buried deposit, there is only a remote possibility of mining natural iron ore in the reservation.

The Vulcan Iron-formation also is a great low grade resource of iron, probably averaging about 30 percent iron. This is similar to material now being mined and concentrated elsewhere, such as the Marquette Range in Michigan and Mesabi Range in Minnesota. It is likely that some of this iron-formation is beneath parts of the reservation but if so, it is far from being an economic deposit at present, largely because of the 700 to 800 feet of overlying Cambrian and Ordovician rocks.

Copper. There is also a possibility of a copper resource in the Randville Dolomite. An equivalent stratigraphic unit, the Kona Dolomite, near Marquette, Michigan, about 60 miles to the north, contain a large known resource of copper in shaly beds. That deposit is presently being evaluated to determine if it is economic. In view of the probable similarity of rock types, there is some potential for similar mineralization in the Randville in the reservation, but, again, exploration is greatly hindered by a cover of younger rocks.

Nonmetallic Mineral Resources

General. Sand and gravel, limestone, peat, and marl are all found in this area. In considering development of these resources on the Hannahville Reservation, it must be remembered that all of these products are available in other parts of Michigan, often in larger quantities, in higher grade deposits, or closer to markets.

Sand and Gravel. The sorted sands and gravels found in the glacial deposits throughout this part of Menominee County are periodically worked for local construction projects. The topographic maps for the area adjacent to the Indian lands show numerous sand and gravel pits (Figure 6). One pit is shown within the reservation boundaries. The Bureau of Indian Affairs reports the following production statistics for the Hannahville Reservation. No dollar value is available and there has been no production since 1968.

1966	gravel	2,364 cu. yds.
1967	gravel and borrow	16,875 cu. yds.
1968	sand	2,796 cu. yds.

There is little chance for any permanent development because of the common and widespread occurrence of sorted sand and gravel and the economic necessity of quarrying as near as possible to the market. Any effort to develop a sand or gravel pit would necessarily be on a small scale in answer to a specific local demand. To facilitate development in answer to this demand, efforts should be made to locate and analyze well-sorted deposits within the reservation so that they could

be developed promptly as construction projects are planned for the area.

Limestone. The Ordovician Trenton Limestone and the Black River Group underlie all of the eastern Menominee County. Throughout the reservation area rock outcrops are not common but in many places glacial cover is thin and the bed-rock lies within 3 feet of the surface (Moon and others, 1923). The Black River Group has massive beds of fine-grained limestone, some argillaceous and siliceous beds, and a dolomitic bed. The base of the group is generally sandstone. The younger Trenton Limestone is more fossiliferous than the Black River and, in its exposures in Menominee County, has three facies: an upper crystalline, high magnesian limestone bed, some sandy or cherty beds, and a bottom section of blue shale and dark limestone (Smith, 1915). Total thickness of these two units is about 400 feet.

The massive limestone of the upper part of the Trenton was quarried near Escanaba in the early 1900's as a building stone (Russell, 1905). In general, the limestone is too impure to be of much commercial value especially since Michigan has other extensive deposits of pure, high grade limestones and dolomites where Silurian and Devonian rocks are found.

References describing the limestones in the immediate vicinity of the Hannahville Reservation are scarce, but Verwiebe (1926) comments that outcrops in the vicinity of the southern section of the Hannahville Reservation are the middle part of the Trenton Limestone, which is generally thin bedded and argillaceous. In R. C. Hussey's report

on "The Trenton and Black River Rocks of Michigan" he describes an outcrop about 2 miles west of the southern portion of the Hannahville reservation as being argillaceous, having thin irregular beds and lenses of dolomite.

There appears to be little chance for development of limestone in the area. The literature suggests that the limestone throughout the reservation is thin bedded and impure. The common uses for low grade limestone have substitutes or limited markets; glacial gravels are substituted for many of the uses of crushed limestone and the decline of agriculture in the area has reduced the market for agricultural lime.

Peat. The soils of Menominee County were mapped in 1923 by the U. S. Department of Agriculture (Moon, and others, 1923). Moon's map shows small, thin peat deposits occurring generally between the drumlins. His report states that the peat is well decayed to a depth of 18 to 24 inches and is generally underlain by an additional foot of less well-decayed woody peat.

The occurrence throughout Michigan of extensive and thick deposits of peat that are being energetically marketed make the Hannahville deposits of very limited interest.

Marl. In 1927, the Michigan Geological Survey made a survey of the marl deposits of Menominee County (Barton, 1927). Only one deposit of sufficient size to be worked was discovered near Hannahville. It is at Jasper Lake, 4 miles southwest of the southernmost part of the reservation. No other deposits were located in the area.

Recommendations

The outlook for finding any valuable mineral resource on the Hannahville Reservation is poor. However, as a source of intermittent income, it is recommended that sand and gravel deposits on Indian land be located and analyzed to be readily available as markets arise.

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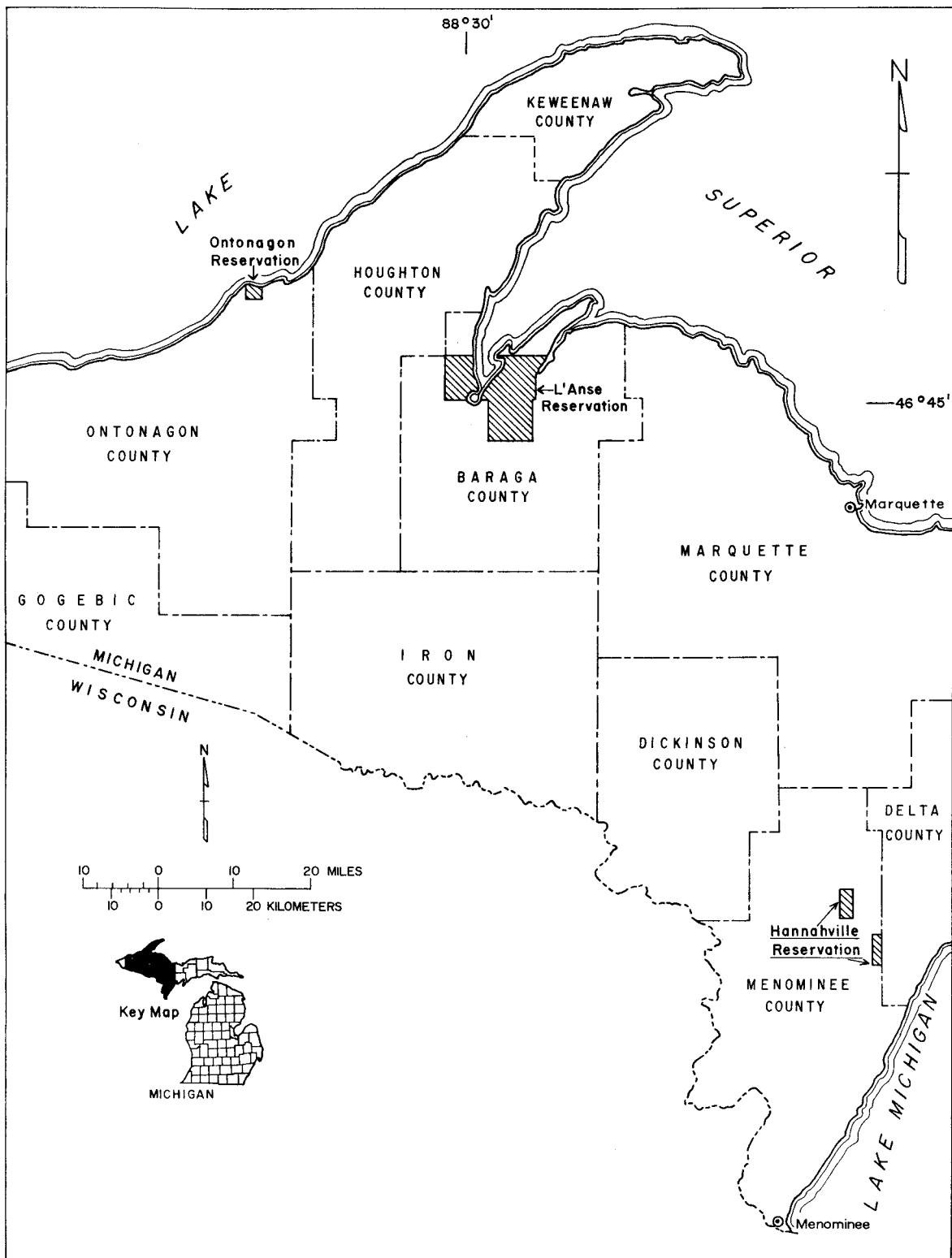


Figure 1. Map of a portion of Northern Michigan showing locations of L'Anse, Ontonagon and Hannahville Reservations.

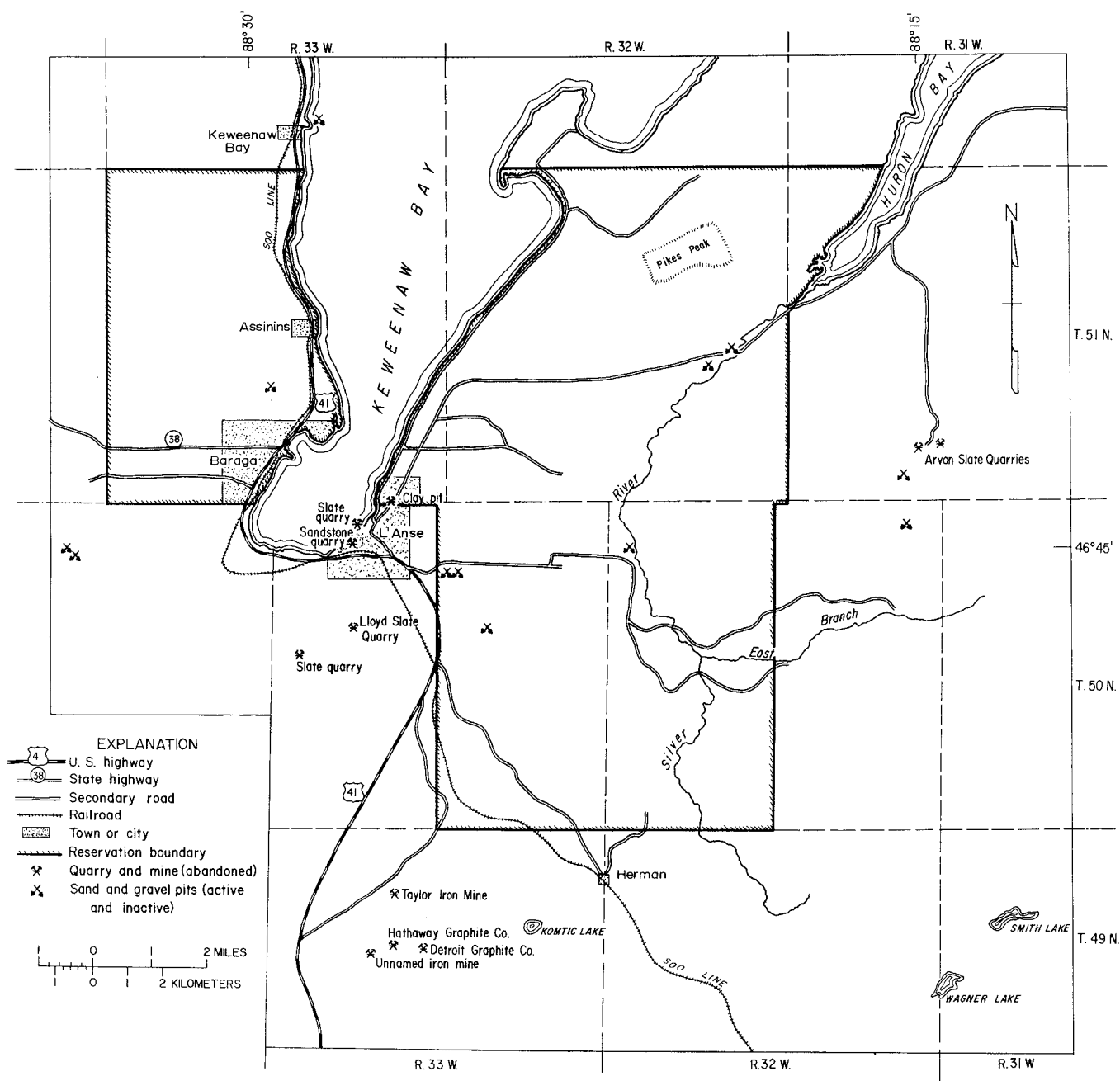


Figure 2. Map showing location of mines and quarries, now mostly inactive, on and near the L'Anse Indian Reservation, Baraga County, Michigan.

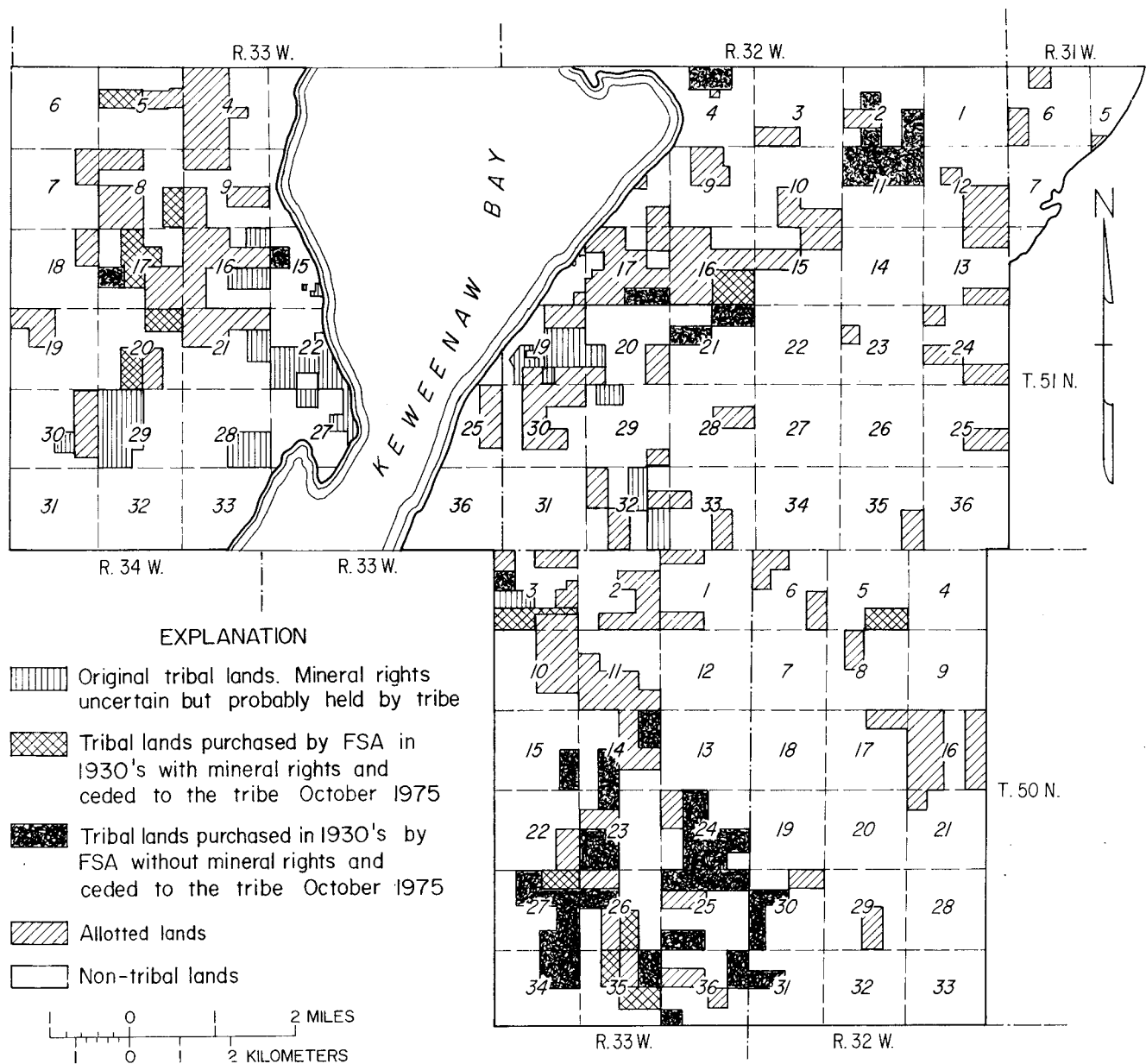


Figure 3. Map showing land and mineral ownership on L'Anse Indian Reservation.

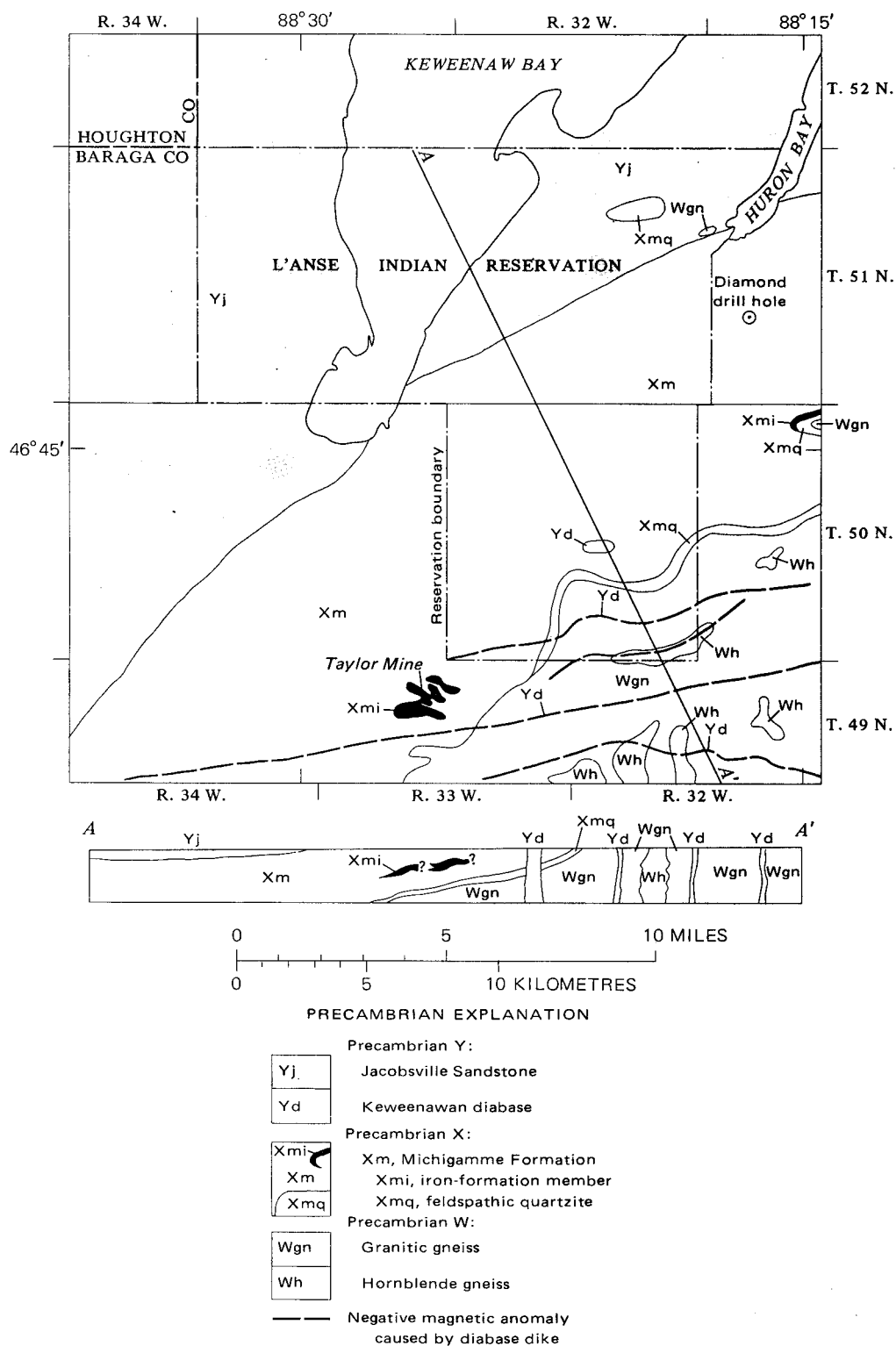


Figure 4. Geologic map of L'Anse Indian Reservation.

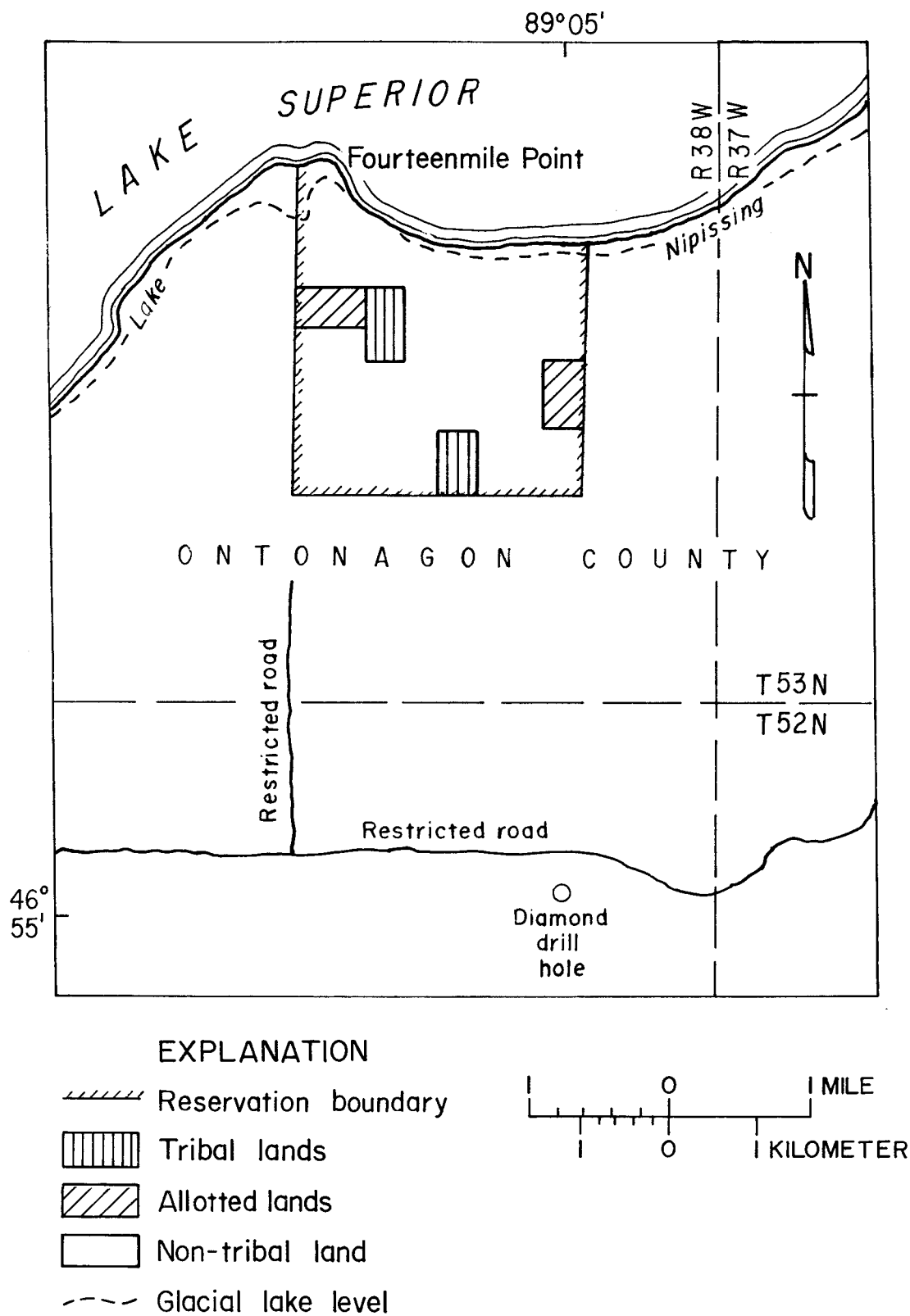


Figure 5. Map showing the Ontonagon Reservation, Indian land ownership and approximate level of Glacial Lake Nipissing.

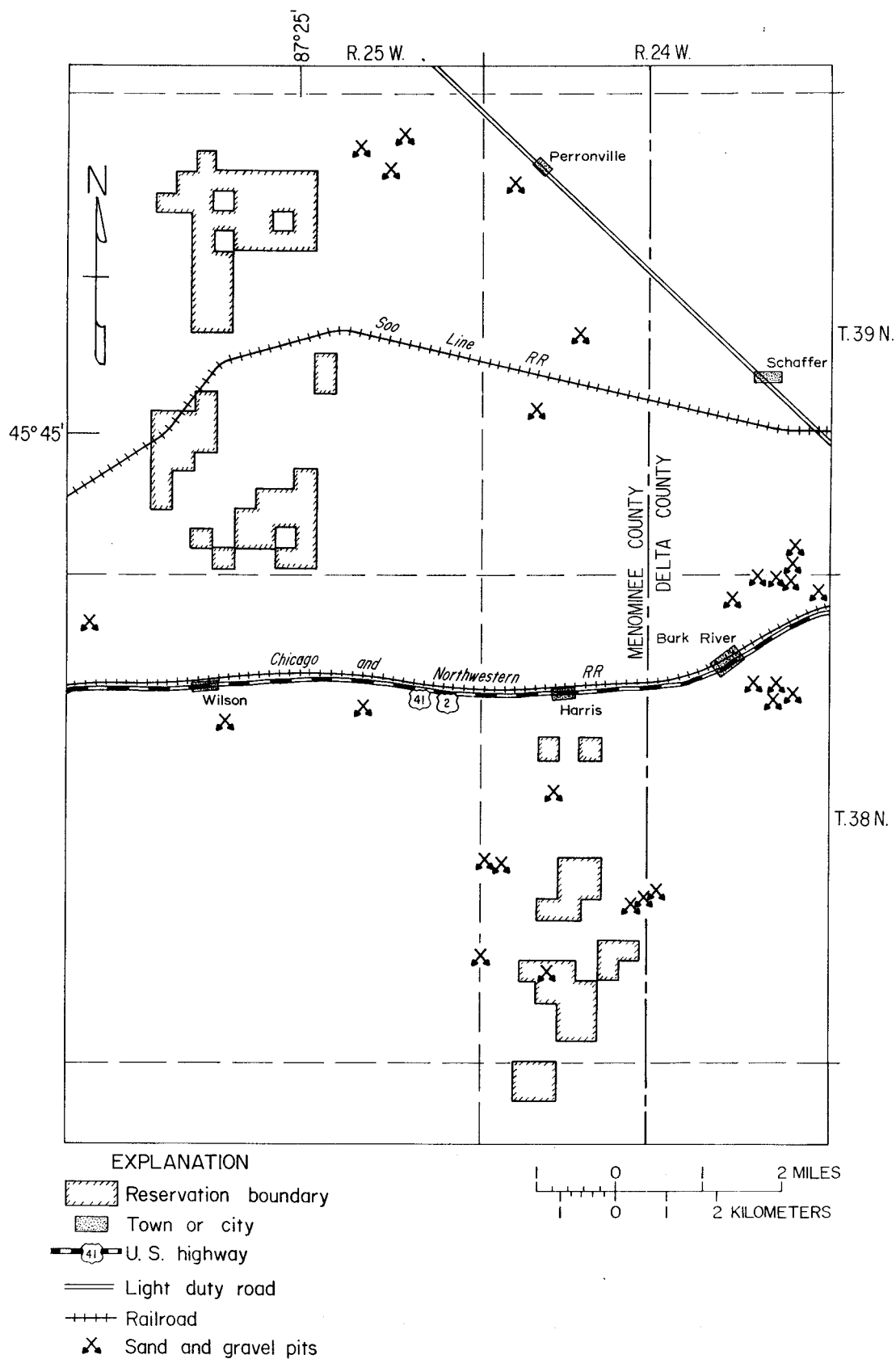


Figure 6. Map showing location of sand and gravel pits on Hannahville Indian Reservation.

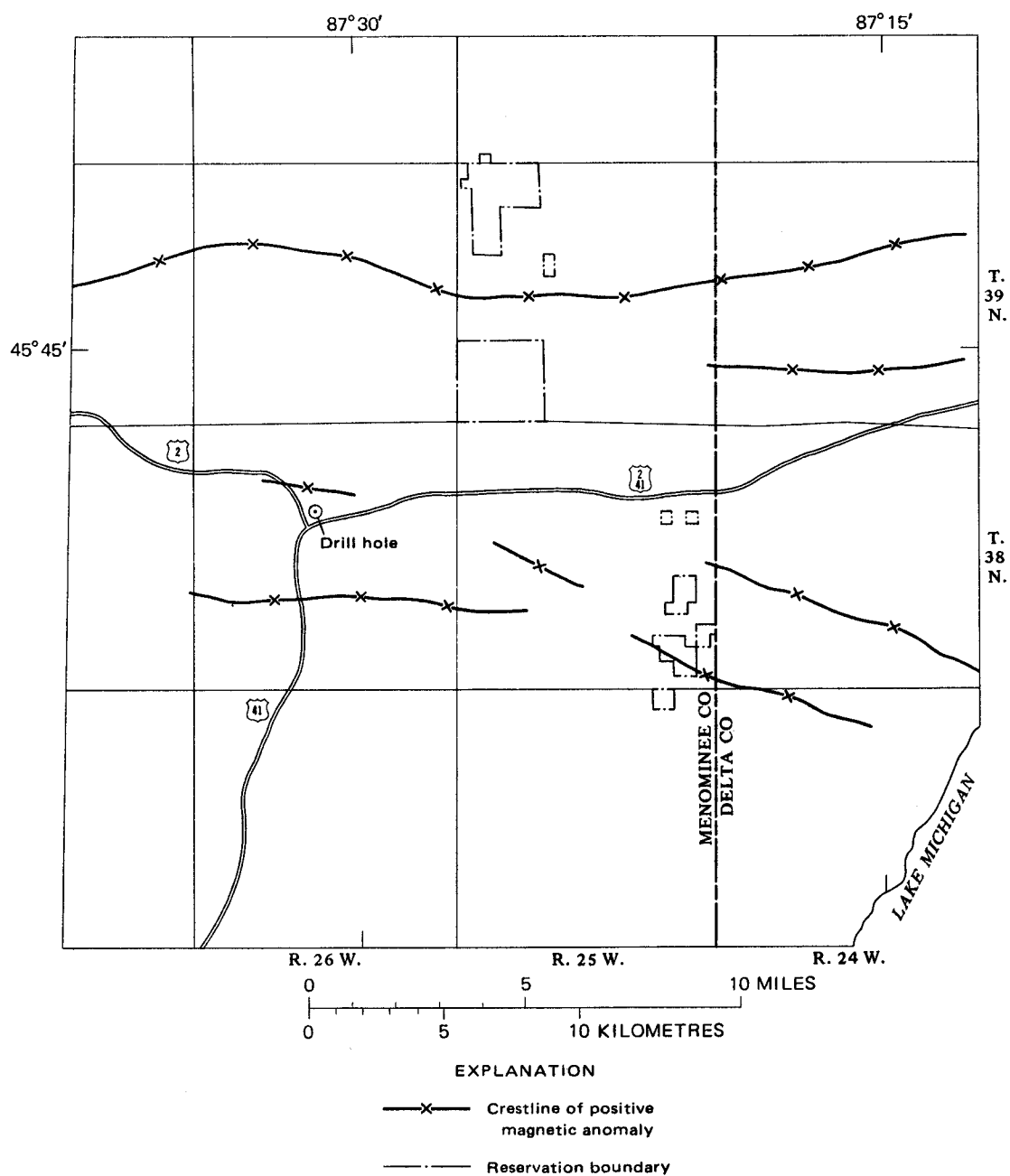


Figure 7. Map showing magnetic anomalies on Hannahville Indian Reservation.